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data element flagged as questionable with an asterisk is found, the full block of data that the questionable element is contained in is displayed on the meteorologist's computer terminal. The meteorologist is asked whether the data element should be retained. To aid in the decision of whether to keep the data, the meteorologist will have available a complete listing of comparison and test failures for the data block being examined. To keep or delete the data element in question, the operator answers a yes/no question. A decision to keep the data element results in no change to the data. A decision to not keep the data element results in the element being replaced by a -999. The quality controlled data are written, along with any changes due to invalid or corrected questionable data, into a new file with the same structure. The quality controlled data file remains unchanged and all flags remain with their data elements in the corrected data file.

The PASCAL program "Random" reads the meteorological data out of the sequential access data files containing the corrected data. "Random" stores data in random access files representing the month during which the data were collected. Each time that a new monthly random access file is opened, the file is first created in its entirety with -999s written in place of the meteorological data. The new monthly random access file is then updated using the contents of the corrected data file. If the appropriate monthly random access file exists, the only step that "Random" takes is to update the file. Once corrected meteorological data have been stored in the random access files, they can be retrieved and displayed in easy-to-read tabular format using the PASCAL program "Out."

FUTURE WORK

No future work is planned.

DUST TRANSPORT - WIND-BLOWN AND MECHANICAL RESUSPENSION

G. Langer

OBJECTIVE

The purpose of this study is to understand and quantify the physical processes that lead to the resuspension of soil particles contaminated with plutonium. At Rocky Flats Plant (RFP), there are two contaminated sites about 50 m southeast and southwest of the East Gate. These adjacent sites are known as the pad field and east field. The results of this research will be used to model local plutonium movement and to estimate population dose.

PRIOR WORK

Studies on dust transport have been conducted at Rocky Flats Plant for 8 years. See the previous progress report for information on the most recent work.[1]

EXPERIMENTAL METHOD

During the reporting period, the vertical plutonium particle flux study was completed and a statistical analysis of the data carried out. Also, major research efforts dealt with the definition of plutonium resuspension from grass by wind and from soil by rain splash.

RESULTS AND DISCUSSION

Vertical Plutonium and Dust Flux in the East Field

Methods

The previous progress report provides details of the sampling procedures.[1] The sampling scaffold stands about 100 m southeast of the East Gate. Three high-volume air samplers, with 15-μm cutpoint size-selective inlets, collected dust samples at 1, 3 and 10 m above the ground. The vertical flux data help to define the amount and dispersion pattern of the plutonium resuspended from the pad and east field soils.

Results

Table 2 and Figures 8 through 13 summarize the results of 34 months of sampling, November 1982 through August 1985. The results for this year

TABLE 2. Dust and Plutonium-239 Concentration From Vertical Dust Flux Tower, November 1982 - August 1985

Sample Period	1 m Resp.[a]	1 m Inh.	1 m Coarse	1 m Total	3 m Resp.	3 m Inh.	3 m Coarse	3 m Total	10 m Resp.	10 m Inh.	10 m Coarse	10 m Total	S7-S9 E. Gate Samplers[b]	Local Background[c]
Dust Concentration ($\mu g/m^3$)														
Nov-Dec 82	8.1	7.3	20	35	No data at 3 m collected until January 1984.				6.8	3.8	11	22		
Jan-Feb 83	8.9	7.1	36	52					7.9	5.4	19	32		
Mar-Apr	11.0	9.6	22	43					10.0	6.1	14	30		
May-June	6.4	8.8	30	45					6.4	8.0	18	32		
July-Aug	8.0	10.0	27	45					9.3	9.0	28	46		
Sept-Oct	7.4	14.0	24	45					8.4	12.0	23	43		
Nov-Dec	9.3	7.0	21	37					7.3	4.5	10	22		
Jan-Feb 84	8.7	11.0	47	67	8.3	10.0	23	41	8.0	7.7	26	42		
Mar-Apr	9.0	11.0	27	47	5.7	7.6	19	23	6.3	7.1	15	28		
May-June	6.9	12.0	26	45	6.9	11.0	25	43	6.4	9.7	20	36		
July-Aug	8.9	15.0	24	48	7.6	12.0	20	40	7.0	10.0	18	35		
Sept-Oct	7.3	13.0	21	41	10.0	12.0	21	43	8.1	9.2	14	31		
Nov-Dec	6.2	11.0	45	62	6.3	9.7	54	70	5.5	7.6	36	49		
Jan-Feb 85	14.0	12.0	26	52	14.0	9.7	20	44	13.0	7.2	16	36		
Mar-Apr	7.0	12.0	34	53	7.2	10.0	26	43	7.2	9.1	24	40		
May-June	6.1	13.0	35	54	6.2	13.0	35	54	7.1	13.0	35	55		
July-Aug	8.2	13.0	20	41	8.2	11.0	19	38	8.1	10.0	18	36		
Plutonium-239 Concentration (aCi/m^3)														
Nov-Dec 82	4.5	4.6	55	64	No data at 3 m collected until January 1984.				26.0	26.0	44.0	96.0	250	2
Jan-Feb 83	11.0	8.0	190	210					7.9	3.6	40.0	51.0	260	1
Mar-Apr	5.5	8.6	45	59					28.0	9.1	10.0	47.0	200	4
May-June	5.6	29.0	51	86					8.9	4.5	28.0	41.0	650	4
July-Aug	4.9	19.0	52	76					2.4	5.8	19.0	27.0	580	4
Sept-Oct	1.4	19.0	27	47					0.9	7.0	49.0	57.0	340	1
Nov-Dec	0.0	0.2	31	31					0.0	0.0	4.9	4.9	130	2
Jan-Feb 84	3.1	20.0	320	340	1.7	2.7	17.0	21	0.0	0.0	35.0	35.0	160	2
Mar-Apr	0.48	7.9	92	100	2.6	13.0	32.0	48	3.7	1.5	15.0	20.0	360	4
May-June	4.8	23.0	99	130	0.0	13.0	60.0	73	4.7	0.0	26.0	31.0	380	5
July-Aug	5.2	32.0	91	130	24.0	11.0	56.0	91	5.8	4.2	14.0	24.0	880	2
Sept-Oct	0.8	53.0	42	96	43.0	12.0	82.0	140	3.4	4.3	13.0	21.0	400	4
Nov-Dec	1.3	12.0	380	390	1.0	Pu recovery too low			0.3	1.2	46.0	48.0	270	5
Jan-Feb 85	0.4	1.7	22	24	0.8	0.5	8.9	10	0.3	0.4	2.6	3.3	190	1
Mar-Apr	0.8	6.5	97	100	0.6	2.9	22.0	26	0.3	1.1	11.0	12.0	460	2
May-June	16.0	110.0	62	190	13.0	18.0	290.0	320	8.2	610.0	160.0	780.0	430	0
July-Aug	24.0	45.0	88	160	60.0	8.5	44.0	110	2.0	14.0	20.0	36.0	510	2

a. Size range: Respirable <3 μm
Inhalable 3-15 μm
Coarse >15 μm

b. Average of samplers S7, S8 and S9 for the same sampling period as vertical flux samples.

c. Fallout is based on Surveillance Sampler S31 west of the Plant.

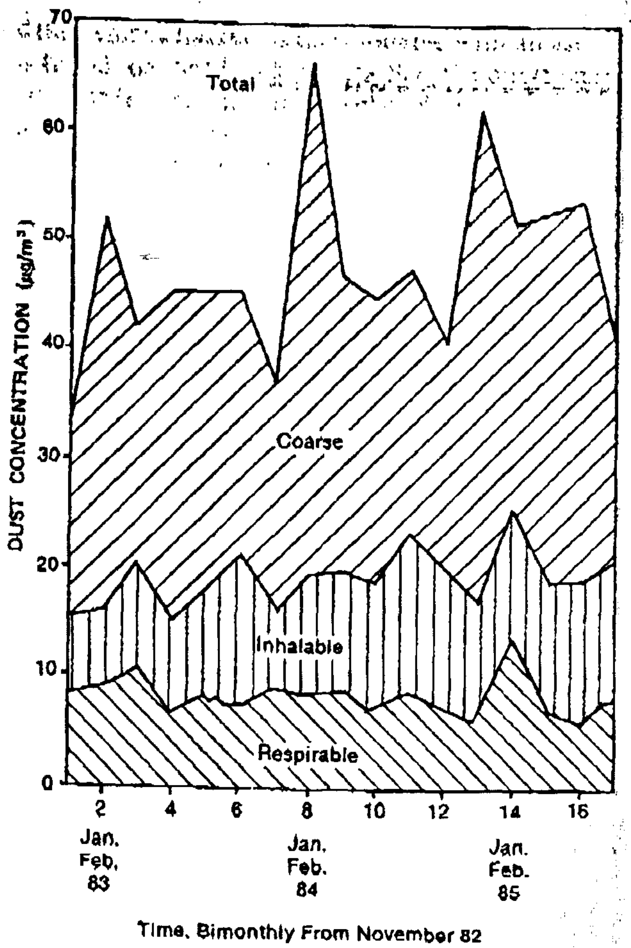
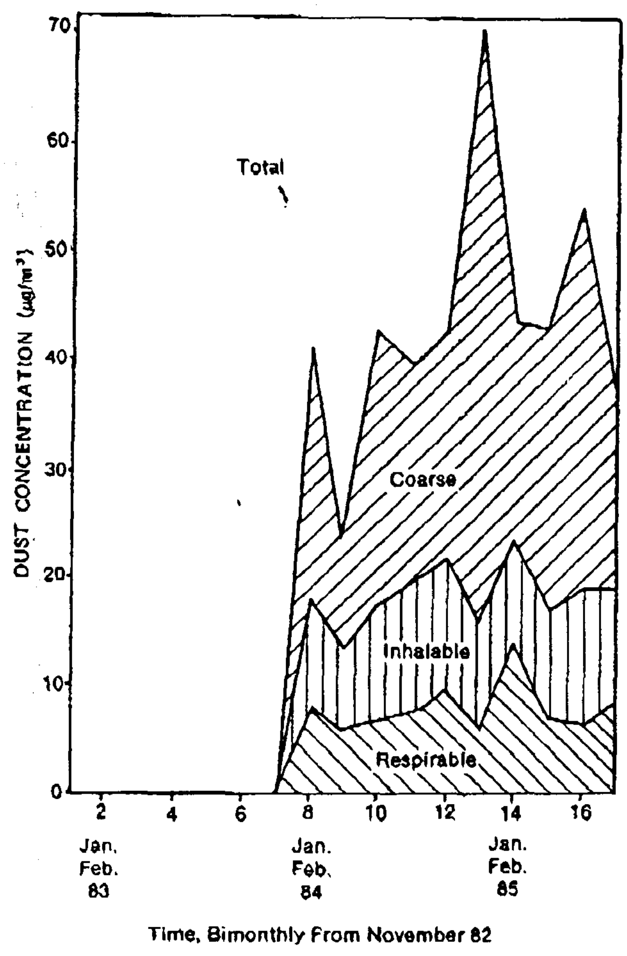


FIGURE 8. Dust Mass Distribution Versus Time at One Meter

FIGURE 9. Dust Mass Distribution Versus Time at Three Meters



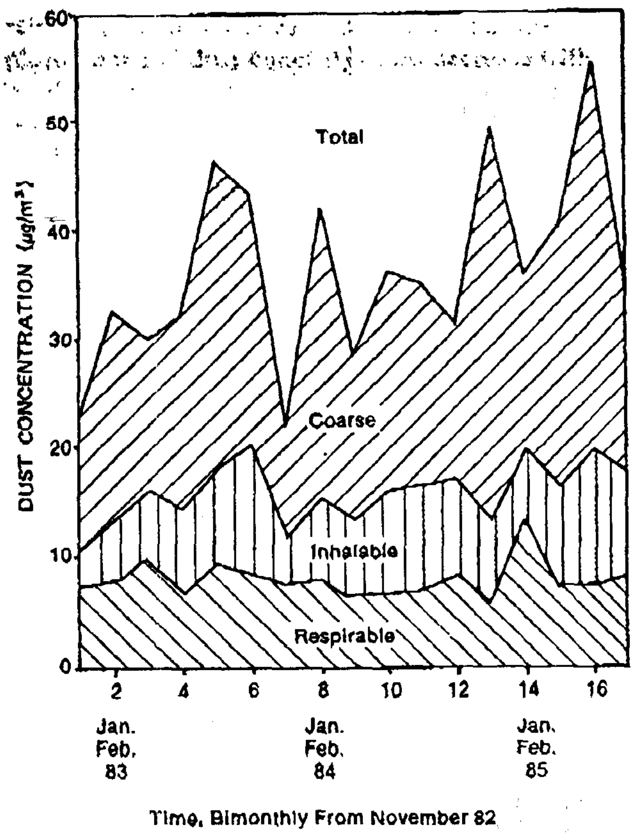
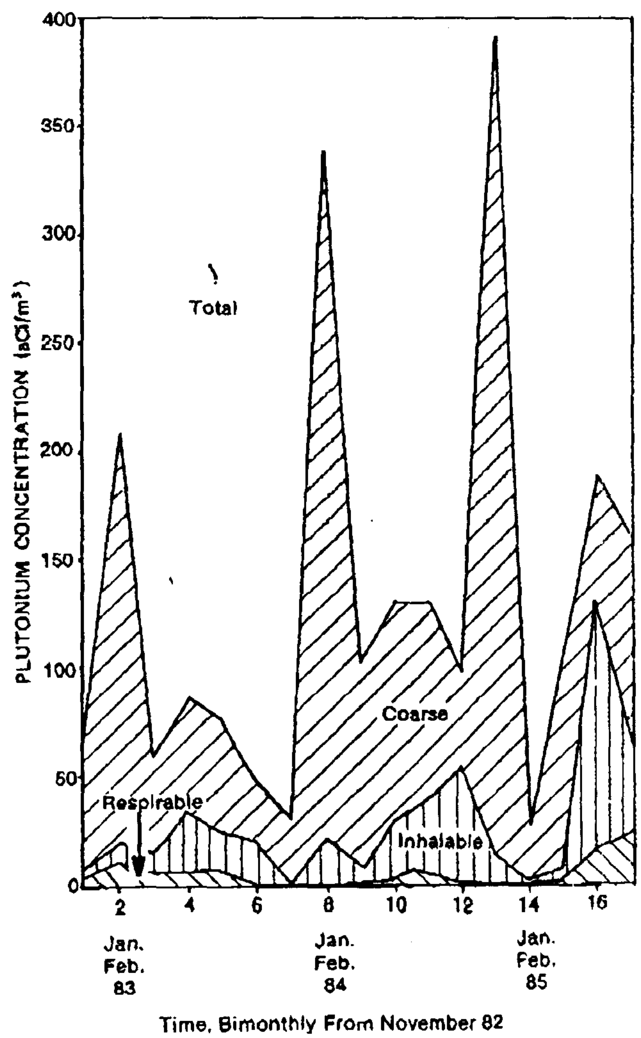


FIGURE 10. Dust Mass Distribution Versus Time at Ten Meters

FIGURE 11. Plutonium Mass Distribution Versus Time at One Meter



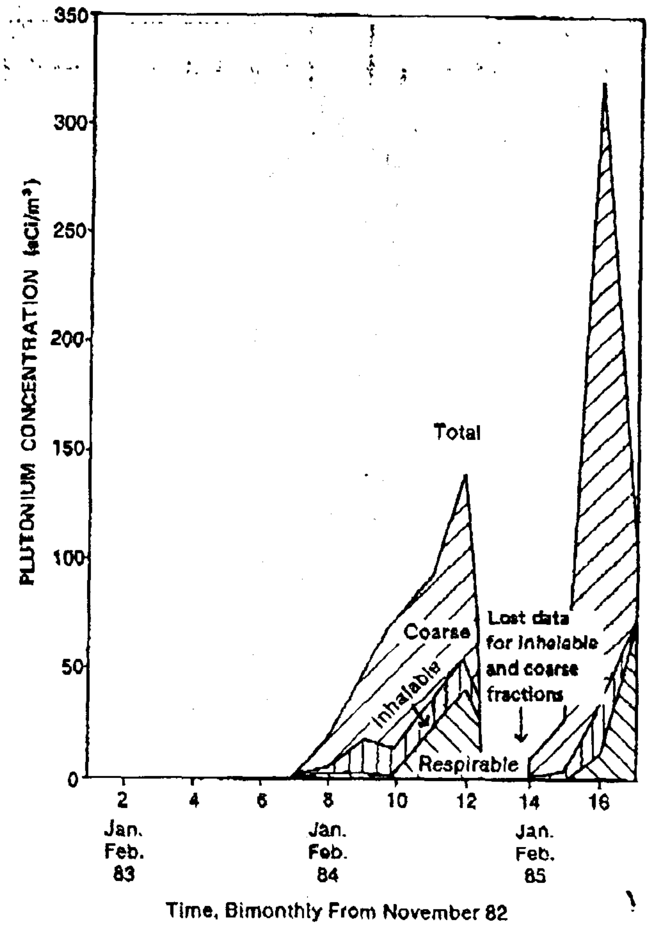
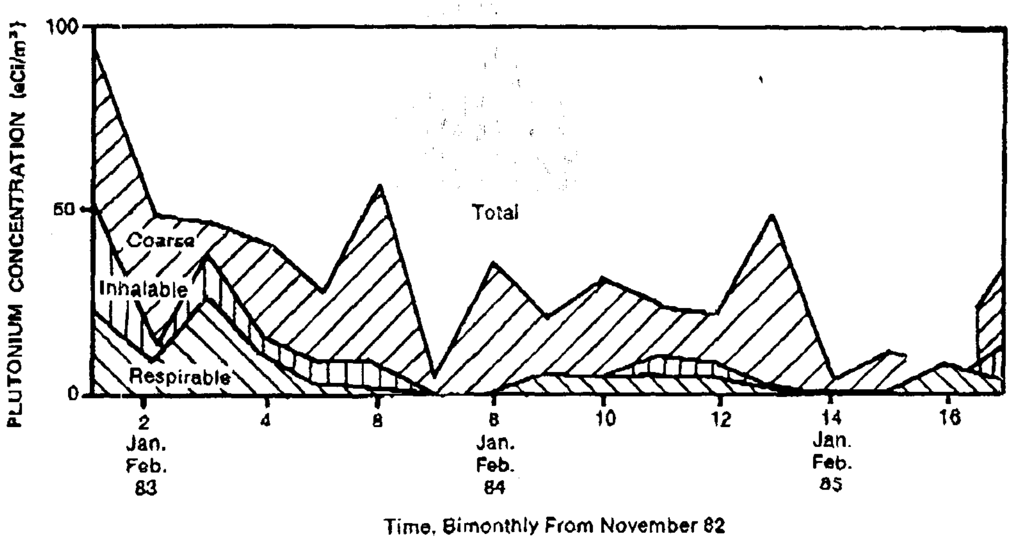


FIGURE 12. Plutonium Mass Distribution Versus Time at Three Meters

FIGURE 13. Plutonium Mass Distribution Versus Time at Ten Meters



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reinforce the past trends, specifically, that the plutonium and dust concentrations decrease with height above the ground, except for the <3-μm respirable fraction.[1] The plutonium in the respirable fraction is always near the background level. This study was terminated at the end of August because the concentration trends were statistically established. An analysis of all the data provides a basis for studies of the environmental effects of resuspended plutonium at RFP.

Table 3 provides an overview of the database given in Table 2 and is used to analyze and generalize the results. The dust concentration trends for all fractions indicate a decrease with height. However, the coefficients of variation for all values are quite high (30%), so statistical tests are necessary to verify that the trends shown are significant. The probability that a given change with height is *not* significant, i.e., a probability <0.05, is given in the bottom row of Table 3. The probabilities show that the decreases in dust concentration with height are definitely significant, except for the respirable dust. This is to be expected since dust of smaller particle size settles more slowly than do larger-size particles. In fact, a 3-μm particle of density 2 g/cm³ settles at 3 cm/min, while a 20-μm particle settles at 180 cm/min.

The plutonium-carrying dust particles do not exhibit the well-defined trends of the dust particles in general. In Table 3, the average plutonium

TABLE 3. *Summary of Dust and Plutonium-239 Concentration Data From Vertical Dust Flux Tower, November 1982 - August 1985*

Sampling Height (m)	Average Dust Concentration (μg/m³) Resp.[a]	Inh.	Coarse	Total
1	8.3 ±1.9 (23)[b]	11 ±2.4 (22)	29 ± 8.3 (29)	48 ± 8.3 (17)
3[c]	8.0 ±2.4 (30)	11 ±1.5 (14)	26 ±11 (42)	44 ±12 (27)
10	7.8 ±1.7 (22)	8.2 ±2.5 (30)	20 ± 7.5 (38)	35 ± 8.9 (25)
Average	8.0	10	25	42
Probability that change with height *not* significant	0.48	0.0004	0.0066	0.0004

Sampling Height (m)	Average Pu-239 Concentration (aCi/m³) Resp.	Inh.	Coarse	Total	E. Gate S7-S9 Air Samplers	Local Background
1	5.3 ± 6.4 (120)	24 ± 27 (110)	100 ±100 (100)	130 ±100 (77)	380 ±200	2.6 ±1.5
3	15 ±21 (140)	9.1 ± 5.9 (65)	68 ± 86 (130)	93 ± 96 (100)	East Gate samplers operate at 1 m only	
10	6.0 ± 8.4 (140)	41 ±150 (370)	32 ± 35 (110)	78 ±120 (230)		
Average	8.8	25	67	100		
Probability that change with height *not* significant	0.71	0.50	0.014	0.31		

a. Size Range: Respirable <3 μm.
Inhalable 3-15 μm.
Coarse >15 μm.

b. Coefficient of variation, %.

c. Covers period from January 1984 through August 1985 only.

concentrations are shown in the lower half of the table. One must keep in mind that the mass fraction of plutonium in the dust is roughly 1×10^{-10}, i.e., 1/10th part per billion. The coefficient of variation is high (140%) in keeping with data near the minimum detectable amount. Only the concentration of the coarse (>15-μm) dust particles, that carry plutonium, decreases significantly with height. About 70% of the plutonium activity resides on the coarse particles, which represent 60% of the dust. The plutonium activity is approximately proportional to the dust mass. It had been expected that the activity would be proportional to the surface area.

Table 3 shows average respirable plutonium concentrations close to three times the background level detailed in the last column of the table. Background plutonium originates from worldwide plutonium fallout due to past atmospheric testing of nuclear weapons. Fallout plutonium should be on <3-μm particles. That is, the plutonium particles in the stratosphere are submicron in size and upon entering the troposphere, they become attached to >3-μm dust particles on the basis of coagulation theory. This was verified experimentally in 1973 at RFP.[2] Therefore, approximately one-third of the respirable plutonium, reported at the East Gate, should come from fallout and the rest from local sources. To verify this hypothesis, some of the air and soil samples were submitted to Battelle Northwest Laboratories, Richland, WA for Pu-240/Pu-239 isotopic analysis by a three-stage mass spectrometer. A ratio of 0.051 represents RFP weapons grade plutonium while a ratio of 0.163 represents fallout plutonium.

Table 4 summarizes the results of the analyses. The soil isotopic ratio is close to 0.051 (weapons grade plutonium) as expected, because the plutonium in the oil leak came from machining weapons parts. The airborne plutonium has a somewhat higher ratio, but the respirable plutonium is not close to the ratio of 0.088 expected from fallout plutonium plus RFP plutonium. We conclude from this result that fallout or background plutonium is now dominated by resuspension of fallout deposited on the soil over the last 30 years, i.e., it is no longer on <3-μm particles. The last atmospheric test took place in 1980 in China and the influx of plutonium from the stratosphere is now at a low level. As shown in this study, resuspended plutonium is carried mostly by particles >10 μm with the fallout plutonium spread throughout the particles; the fallout plutonium cannot be discerned in the presence of resuspended, contaminated soil particles.

With the above understanding of the local plutonium resuspension process from the RFP oil spill site, we want to know if the depleted uranium particles, which also leaked into the soil near the plutonium site, are subject to the same resuspension process. The July-August 1985 dust samples were also examined for uranium. Aliquots of the soil solutes were examined for uranium by fluorescence analysis. On the average, the respirable, inhalable and coarse dust fractions contained 18, 22 and 48 pg/m³ U or 7.8, 8.4 and 18 aCi/m³ respectively (assuming a specific activity for uranium of 3.8×10^{-7} Ci/g). This is similar to the plutonium activity distribution versus size (i.e., the resuspension process for

TABLE 4. Plutonium-240/Plutonium-239 Isotopic Ratios for Airborne Dust and Soil Near Rocky Flats Plant East Gate

Sample Identification	Sampling Period		Pu-240/Pu-239 Ratio ± Std. Error
Resp., Composite of 4 samples	November 1982 - February 1983		0.068 ±0.0001
Resp., Composite of 3 samples	January 1985 - February 1985		0.068 ±0.0004
Inh., Composite of 3 samples	November 1982 - February 1983		0.057 ±0.0002
Coarse, Composite of 3 samples	November 1982 - February 1983		0.067 ±0.0001
Soil, Composite of 5 samples	January 1982 - May 1982		0.054 ±0.0001
		Average	0.063

uranium is similar to that for plutonium). The coarse particles carry most (55%) of the uranium activity. These concentrations are about the same as reported at a number of surveillance air samplers in the vicinity of RFP. In other words, the airborne uranium concentration at the oil leak site are about the same as local background, which is high in this area because of naturally occurring uranium in the soil.

The above discussion dealt with trends discernible from the data averages. We will examine next the detailed data in Table 2 for trends with time and location. The plutonium concentration should be higher in winter, when vegetation decays and strong winds blow predominantly from the west across the contaminated soil toward the samplers. Statistical analysis using the VAX computer SAS package showed no trends with season or time over the three years. Time trends would be indicative of weathering-in effects. To test a longer time period, we analyzed ten years of surveillance sampler data from sites S7, S8 and S9. Figure 14 presents the data in graphic form. These samplers, approximately 100 m southwest of the dust flux tower, report only plutonium-239, no dust data. They also showed no seasonal trends. The concentrations at the three samplers did not correlate with each other on a monthly basis, even though the samplers are only about 50 and 100 m apart. The same lack of correlation was found for the plutonium concentrations from the vertical dust flux samplers that are at the same location but at different heights.

The vertical flux tower dust loadings were next examined for possible correlation on a monthly basis. The total dust loadings did not correlate. The linear correlation coefficient for the respirable and inhalable fractions ranged from 0.74 to 0.84 for the 17 bi-monthly samples. These smaller particles arrive from a larger area and present a more homogeneous population.

I concluded that the dust collected at the vertical dust flux tower originates from many sources, not just from the area that contains the plutonium. Microscopic examination of the dust illustrates this best. The fine and inhalable fraction consists only of mineral or combustion particles. The coarse (>15-μm) particles that carry most of the plutonium, contain approximately 40% organic material (grass litter, pollen when in season, plant fibers, small seeds and insect parts). This information shifted our interest from bare soil as the source of resuspended plutonium to vegetation as another source. The process which transfers plutonium to vegetation also had to be investigated.

Resuspension of Dust From Grass

Methods and Results

The last semiannual report stated that plutonium becomes resuspended from grass at a significant rate, even at low wind speeds.[1] This led to laboratory studies to understand the microphysics of this resuspension process.

The first step involved scanning electron microscopy to find out how and where the grass held dust particles. Figure 15 illustrates dust holding capacity of grass blades as a function of the fine hairs that collect dust like fibers in a filter. Theory shows that a low density of fibrous elements extending into the viscous boundary layer enhances deposition by a factor of 10 to 1000.[3] The grass blade in Figure 16 holds fewer dust particles and in the lower-left corner there is a broken hair. Figure 17 shows a blade with no hairs, but it is not known if the blade had hairs at one time. We speculate that as the grass decays, some of the hairs break off and accumulated dust is easily resuspended. Cataldo and Menzel reported on foliar resuspension rates increasing with particle size.[4,5]

Laboratory tests quantified this dust resuspension process. Filtered air was directed over a few grass blades resting on a screen placed across a small tube serving as a wind tunnel. Some of the air then entered an optical particle counter, which monitored the particles resuspended from the grass. For two 30-min tests at a velocity of 0.2 km/hr, 260 and 130 particles were resuspended per each grass blade 4- and 6-cm long, respectively. Particles were in the 0.2- to 12-μm range, with 5% >1 μm. An air velocity of 0.2 km/hr may seem low; however, the velocity in the grass canopy itself is much lower than that in the free air at the usual

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FIGURE 14. Average Monthly Plutonium-239 Concentration for Samplers S7-S9

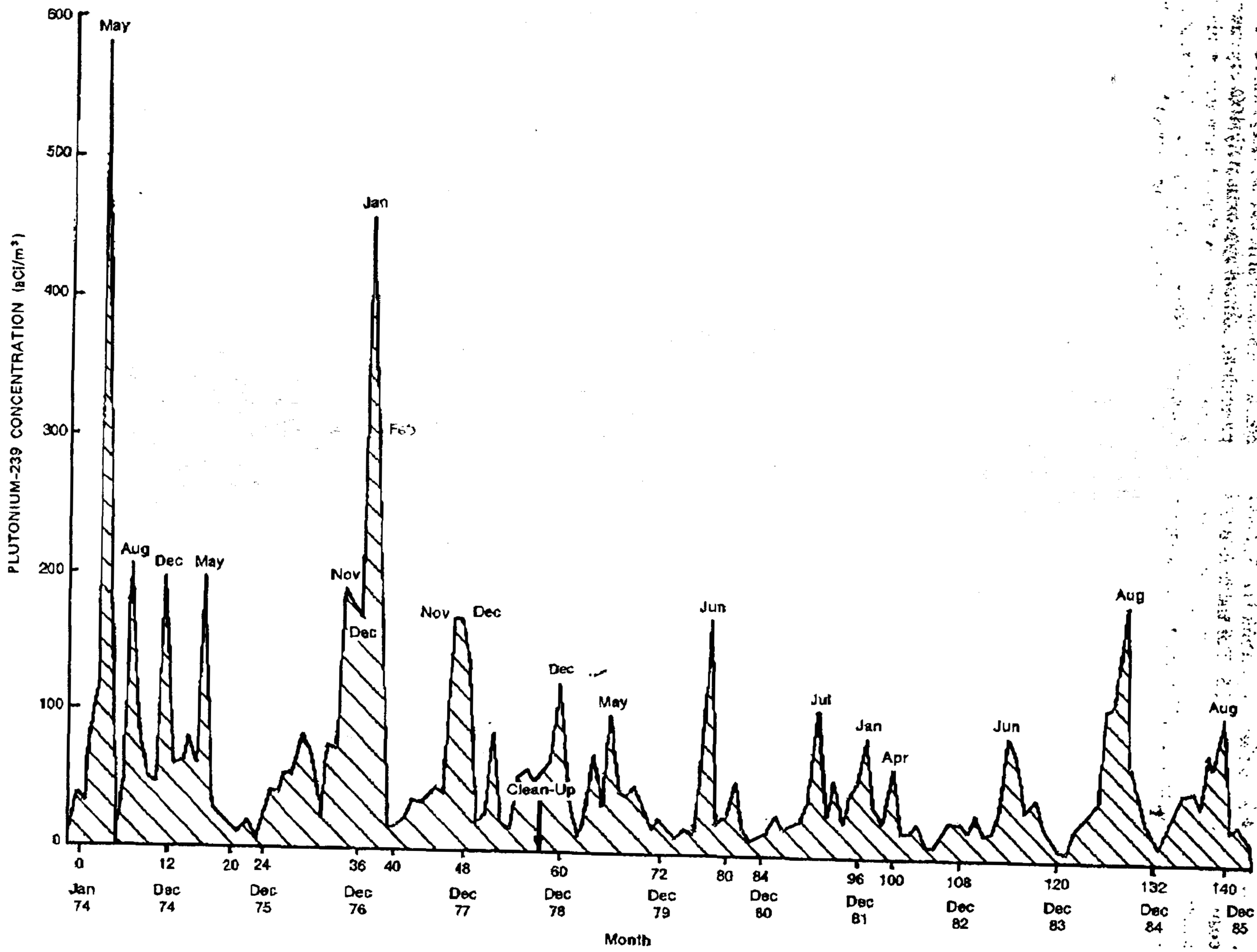

FIGURE 15. Dust Particles Held by Fine Hairs on Grass Blade

reference level of 10 m. Wind speed tends to follow a logarithmic profile as the flow field approaches ground level. A velocity of 0.2 km/hr in the grass, as measured with a thermoanemometer, corresponded to about 10 km/hr at 10 m. This was based on measuring wind velocity at 0.2 m to allow extrapolation to 10 m.[6] Another wind tunnel test at a higher velocity of 1 km/hr (equivalent to 40 km/hr at 10 m) shifted the particle size distribution to 60% >1 μm. 6.21 – 25 mph at 10m

Finally, to determine if particles >10 μm are resuspended when the grass blades naturally flex, grass blades were flexed mechanically in the wind tunnel, which operated at 0.2 to 1 km/hr. A membrane filter collected the dust for microscopic examination. Particles over 10 μm dominated and the particles had a median diameter of 20 μm, with a maximum size of 40 μm. Figure 18 gives a representative view of the particles.

The above data represent exploratory tests. They do show, however, that significant amounts of dust can be resuspended from grass, even at low wind speeds.

Rain Splash as a Source of Resuspended Particles

Methods

The previous report raised the possibility of rain splash as a resuspension mechanism for soil particles.[1] Dreicer showed that rain splash transfers plutonium to plants; however, the possibility that rain splash produces airborne soil particles has not been studied.[7] Gregory reports that plant spores are released into the atmosphere by the impact of rain drops on plants.[8] An important consideration is that even in heavy rainfall, the air is usually not saturated, especially in an arid climate; therefore,

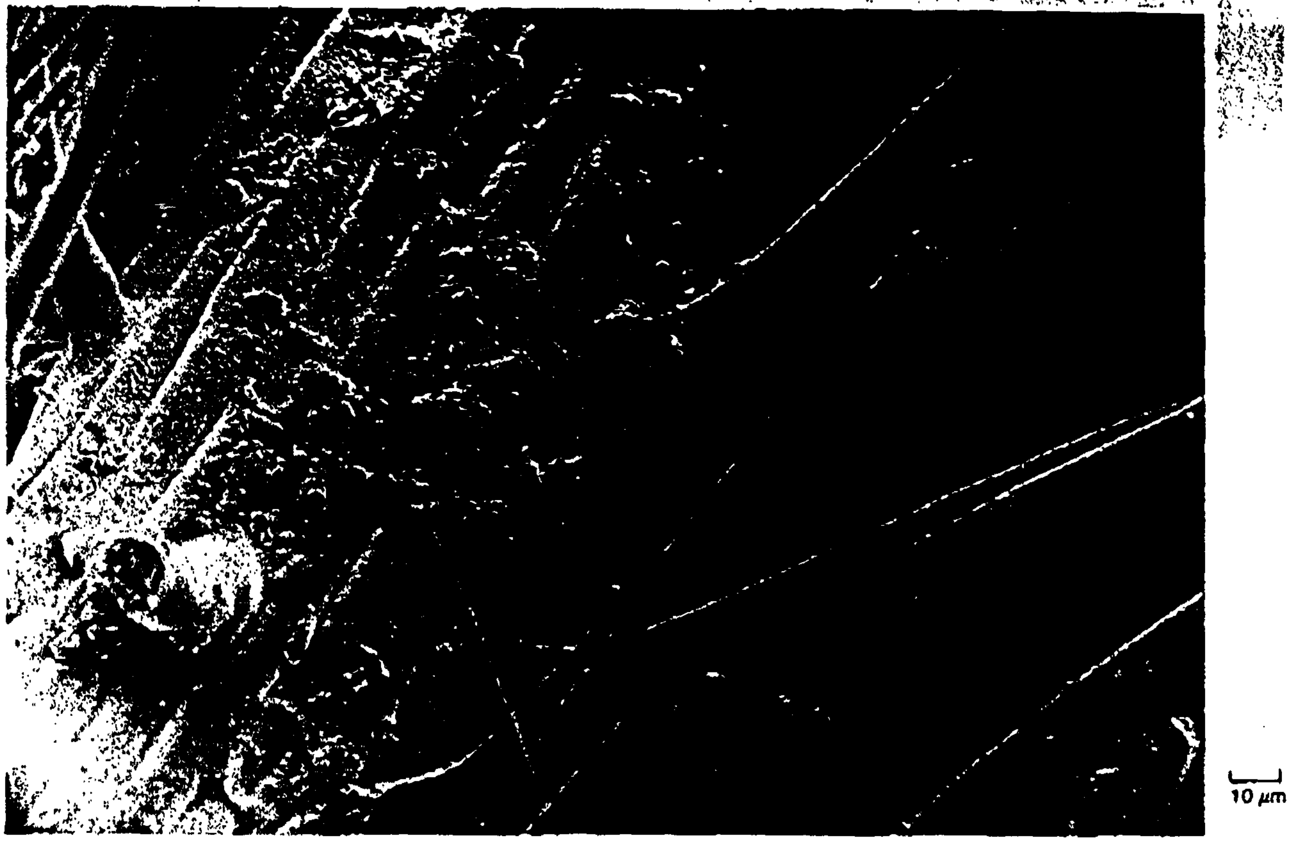

FIGURE 16. Another View of Fine Hairs on Grass Blade With Fewer Dust Particles. Note the broken hair in lower-left corner.

small droplets evaporate. If the droplets contain soil particles, an airborne dust particulate remains after evaporation of the droplet. The removal of such particulates by rain drop washout is not a very effective process.[9]

The laboratory equipment used for initial studies of soil particulate resuspension by rain splash is shown in Figure 19. This research served as a guide for the subsequent field studies with plutonium contaminated soil. The HEPA filter attached to the wind tunnel provides clean air, so that particles resuspended from the soil can be detected by appropriate sampling devices. The latter included a laser aerosol spectrometer to measure the concentration and size of particles in the 0.2- to 12-µm range. A cascade impactor provided mass size distribution data from 0.5 to 20 µm and a filter sampler served to collect all particles for microscopic study. Drops falling from the tip of a burette simulated falling rain drops. The one-meter distance to the target (soil sample), however, did not allow the drops to reach terminal velocity. A 4-mm drop, as generated by the burette, needs at least 6 m to accelerate to terminal velocity. Consequently, the estimates of resuspension are all conservative, because of the smaller than realistic drop impact energy.

Figure 20 shows equipment for study of rain splash in the field with plutonium contaminated soil. The plastic enclosure of the tripod prevents wind from deflecting the drops from the target area. A tube lined with blotting paper surrounds the target area to collect the residue from the large splash drops. The particulate residue from the small satellite

FIGURE 17. Grass Blade With no Hairs. Some dust particles are present.

drops, that evaporate before contacting a surface, are collected for analysis by an open-faced filter holder. This filter holder, oriented in such a way that splash drops cannot reach, allows examination for nuclear tracks, particle size and total plutonium activity. A similar filter collects the background aerosol in the enclosure.

Results

We tested two types of soil, a black soil used for planting shrubs and a typical RFP soil with many small stones. Two tests with black soil generated 160 and 320 particles/drop. The particles ranged from 0.2 to 2 μm. A third test resulted in 100 particles/drop but over a wider size range of 0.2 to 12 μm which suggested the following further tests. The particle counter indicated the presence of even larger particles, but it does not sample them efficiently, i.e., particles >10 μm are lost increasingly by settling in the sample line.

For the next experiments, to more closely simulate rain shower conditions, the soil sample was premoistened to develop a small puddle in the drop impact area. We observed in the above tests that the impact of a drop on dry or slightly moist soil eroded it slightly. Erosion, as referred to here, means the movement of bulk soil by big drops that become airborne for a short distance. This process was monitored by placing blotting paper on the wind tunnel wall and floor to catch the big drops as they settled. They could be seen on the blotting paper as millimeter-size blotches. With dry soil, drop impact seemed to be cushioned by the compression of the loose soil structure, which was compacted when impacted by a drop and absorbed the water. When a puddle formed, the water, upon drop impact, erupted into a small, particles/drop out over a wider size range of 0.2 to 12 μm which suggested the following further tests. The particle counter indicated the presence of even larger particles, but it does not sample

the compression of the loose soil structure, which was compacted when impacted by a drop and absorbed the water. When a puddle formed, the water, upon drop impact, erupted into a small,

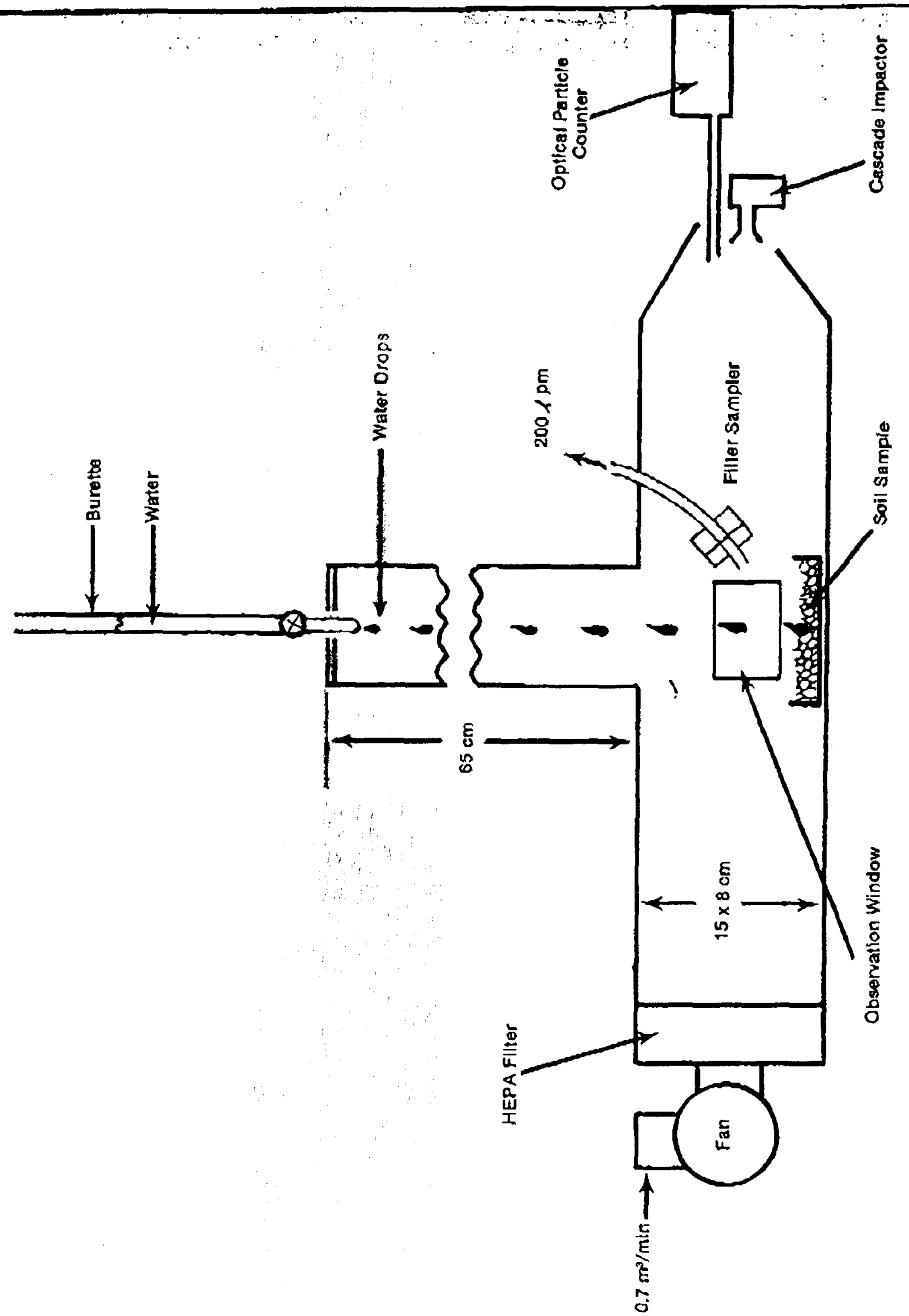

FIGURE 19. Wind Tunnel for Rain Splash Resuspension Studies

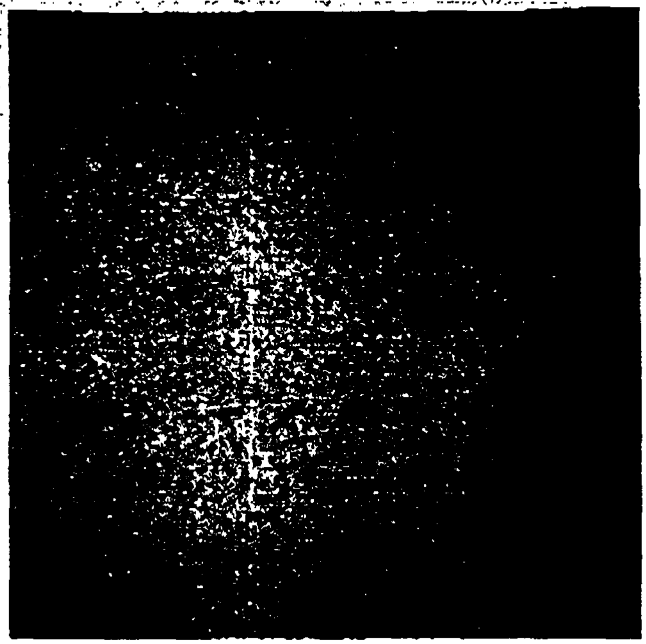

FIGURE 18. Dust Particles Resuspended From Grass Blades Flexed in Wind Tunnel

central fountain that broke up into several large drops. At the same time, the large drops were surrounded by a spray of small drops, so-called *satellite droplets.* This droplet formation was observed with an intense light beam directed over the impact area.

This droplet splash phenomenon is a classic subject of high speed photography, but its implication for soil particle resuspension has not been recognized so far.[10] The puddle apparently contains many suspended soil particles caused by agitation of the impacting drops. These soil particles are then subject to resuspension. When the water puddle was too deep, the formation of drops stopped.

A theory developed by the Los Alamos National Laboratory for the impact of small meteorites on the surface of space vehicles describes the above phenomenon. In the case of meteorites, hypersonic impact fluidizes the metal surface. The energy imparted upon particle (drop) impact will be dissipated in the immediate impact area, if a solid surface exists a short distance away, such as soil. Otherwise, the impact energy will spread out and droplet generation will be reduced. A thin liquid wall forms around the impact point and breaks up into small droplets. This process was simulated numerically by the Los Alamos National Laboratory's Theoretical Physics Div. under the direction of F. Harlow.

The resuspension of the larger airborne soil particles, in the presence of puddles, became the subject of more detailed wind tunnel studies with the cascade impactor and filter sampler to obtain more data on the resuspension of >10-μm particles. The impactor collected particles up to 20 μm. Microscopic examination showed that the numerous smaller (<5-μm) particles consisted of salts leached out of the soil, while the larger particles were soil particles of a mineral nature and organic fibers from plant decay. These larger particles were sampled most efficiently with a filter, which showed particles up to 100 μm. Particles over 10 μm formed at a rate of about 2 particles/drop.

Tests with RFP soil gave similar results to the black soil, except in areas dominated by small stones. In that case, loose soil on the stones provided

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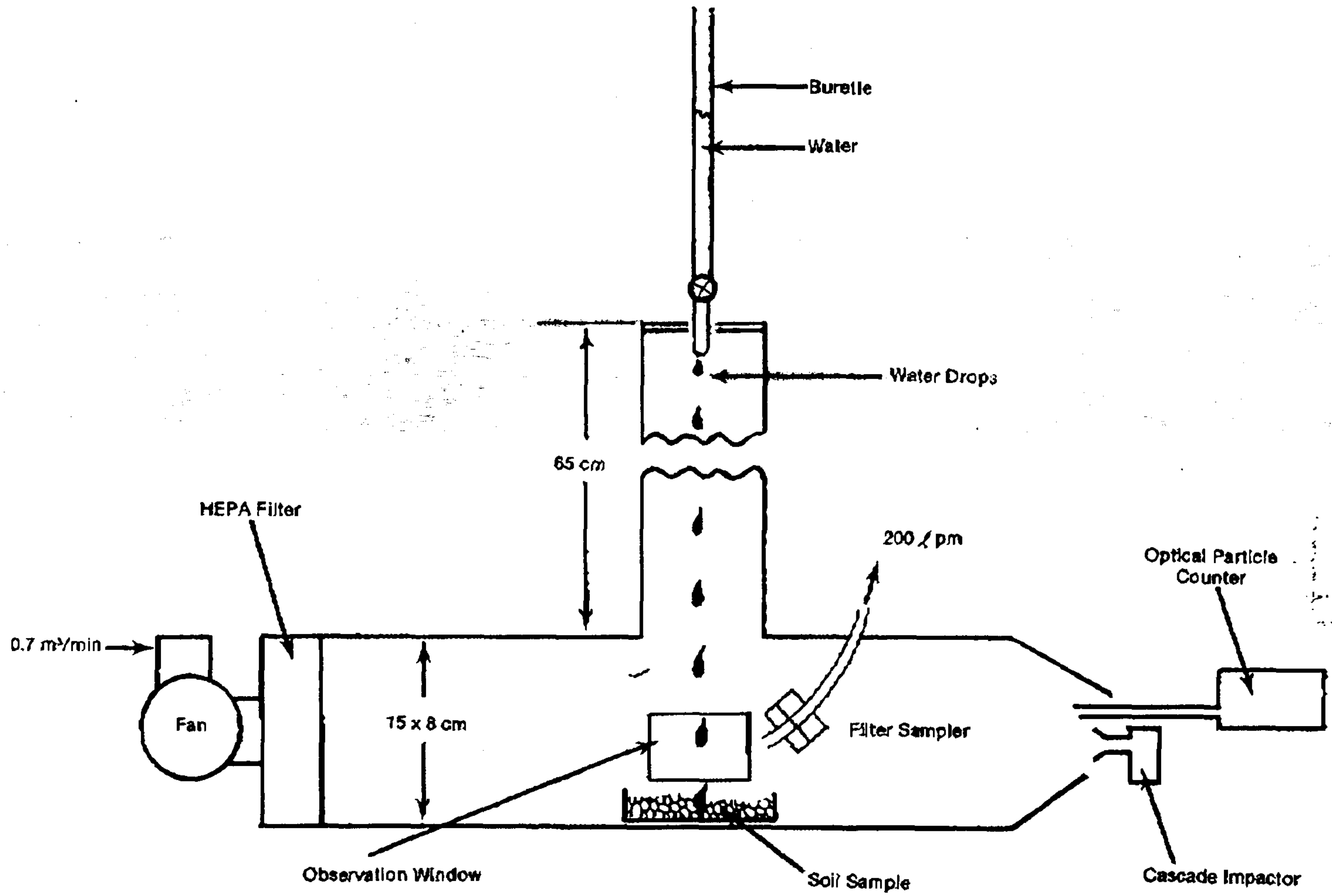
FIGURE 19. Wind Tunnel for Rain Splash Resuspension Studies



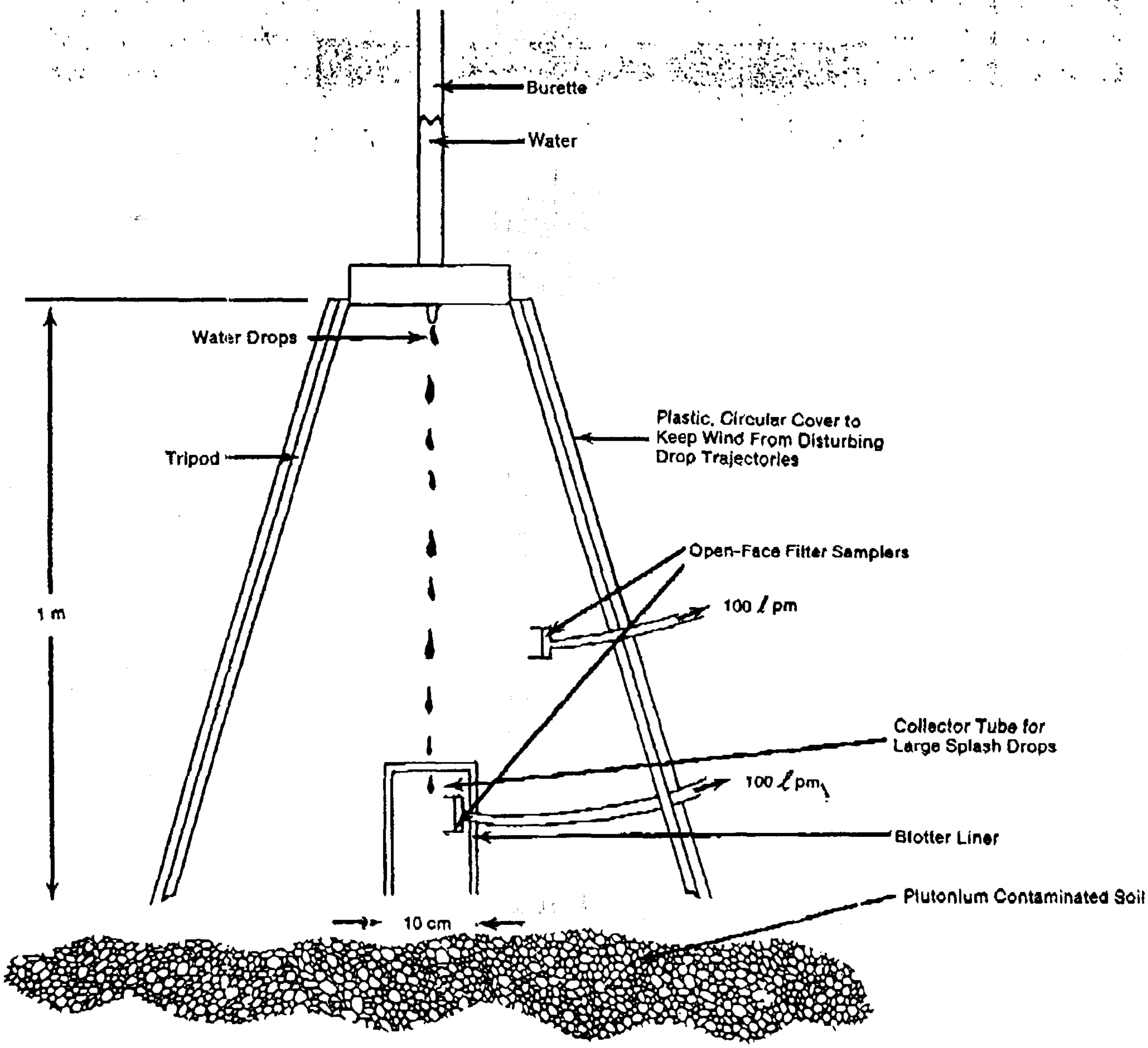


FIGURE 20. Field Equipment to Simulate the Resuspension of Plutonium Contaminated Soil Particles by Rain Splash

particles for resuspension for a short time and then resuspension almost ceased when the stones were washed clean.

The laboratory tests served as a gudie for the following field tests. The field rain splash apparatus (Figure 20) was deployed in an area containing 2,500 pCi/g Pu-239. Resuspended particles from the impact area, when a puddle was present, are shown in Figure 21. Many litter particles are present. The filter was also examined for alpha tracks and then analyzed for total plutonium. Figure 22 shows the alpha tracks from a 0.2-μm plutonium particle. Table 5 summarizes the results based on 1,000 5-mm drops. The rain splash resuspension rate estimate is low, because our apparatus does not accelerate the drops to terminal velocity. To place the number of 1,000 drops in perspective,

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FIGURE 21. Particles Resuspended by Rain Splash

a. Particle residue on blotting paper from large splash drops.

b. Airborne particles from satellite drops.

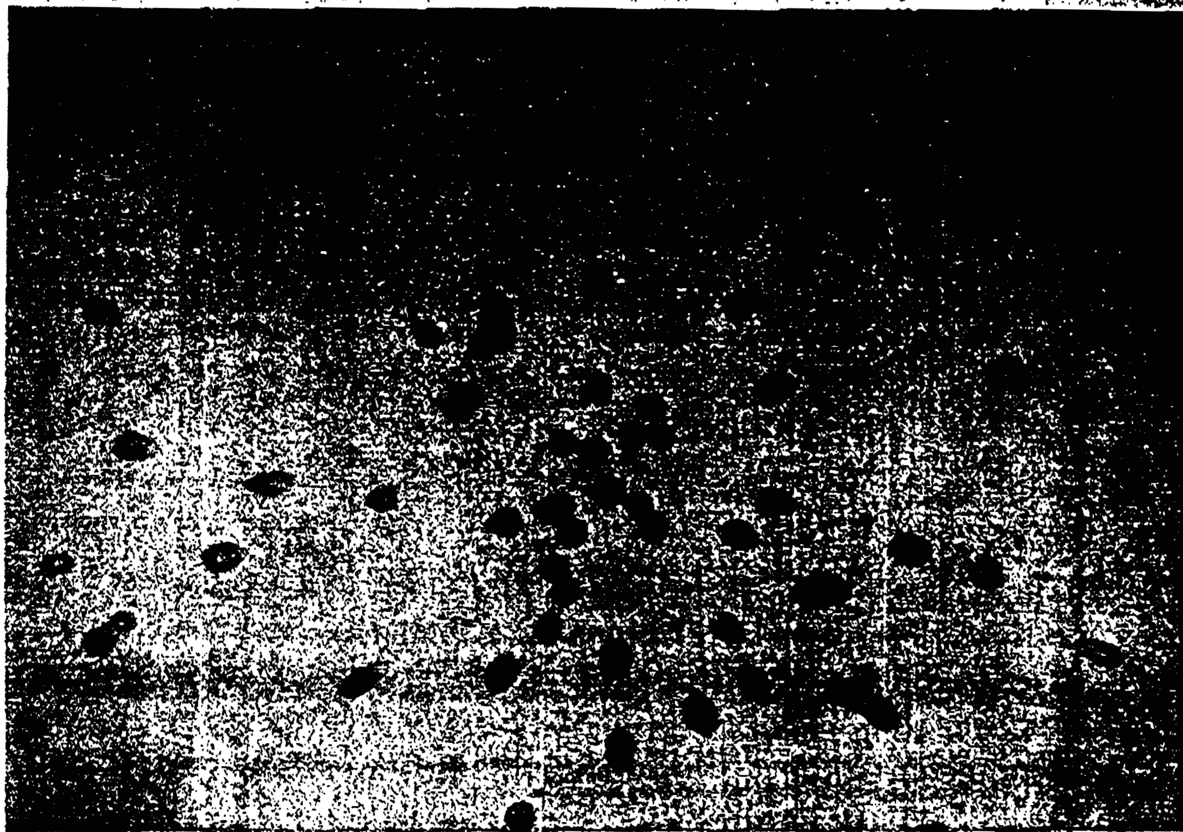

FIGURE 22. Alpha Tracks From a 0.2-μm Plutonium Particle Resuspended by a Small Splash Drop

TABLE 5. Resuspension of Plutonium Particles by Simulated Rain Splash From Contaminated Soil

Parameter	Value
Number of soil particles	2,500
Number of plutonium particles	110
Size range of soil particles	10 - 100 μm
Size range of plutonium particles	0.08 – 0.20 μm
Total activity of plutonium particles	3 pCi

1,000 5μm drops

rainfall in our area should give about 500 million drops/m^2/year. It should be noted that the highest airborne plutonium concentrations often occur in the summer (see Figure 14), a time of heavy shower activity.

CONCLUSIONS

The vertical plutonium and dust flux measurements near the East Gate were completed. The data, which are statistically significant, show that plutonium from the contaminated fields is resuspended on host soil particles at a rate proportional to the mass of the host particles. Many of these particles are from grass litter. Only small amounts of respirable dust are resuspended; consequently the resuspended plutonium does not present a health hazard. The respirable particle concentration does not change with height. For the coarse particles (>15-μm), the concentration of plutonium and dust

b. Airborne particles from satellite drops.

decreases by a factor of 3.1 and 1.9 respectively between 1 and 10 μm.

FUTURE WORK

The research on plutonium resuspension mechanisms showed that resuspension from grass blades and by rain splash are probably the dominant sources for airborne plutonium, contrary to the original perception that wind erosion would be the dominant force. These mechanisms now need to be integrated into a unified transport model.

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EVALUATION OF PM-10 COMMERCIAL INLETS FOR NEW SURVEILLANCE AIR SAMPLER

G. Langer

OBJECTIVE

The inlet for the present Rocky Flats Plant (RFP) surveillance air sampler does not technically meet the new, tentative PM-10 (<10-μm particle mass) criteria for sampling the hazardous fraction of airborne dust.[1] The RFP air samplers sample the 0- to 30-μm fractions, while the EPA plans to regulate only particles that deposit in the respiratory system (particles <10-μm aerodynamic equivalent diameter). However, DOE guidelines for DOE nuclear facilities and EPA may require that >10-μm particles are recovered for analysis, due to the more stringent health consideration for radionuclides.[2] The purpose of this project is to select a commercial inlet and modify it, if

5. R. G. Menzel, "Airborne Radionuclides and Plants," in *Agriculture and the Quality of Our Environment*, N. C. Brady (Ed.), American Association for Advancement of Science, Section on Agriculture, American Society of Agronomy, Washington, D.C., pp 57-75, 1967.

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for DOE nuclear facilities and EPA may require that >10-μm particles are recovered for analysis, due to the more stringent health consideration for radionuclides.[2] The purpose of this project is to select a commercial inlet and modify it, if necessary, to meet the requirements set forth by EPA and DOE.

There is no EPA approved PM-10 inlet design; EPA has instead issued a performance specification.[3] The user must demonstrate compliance.

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